Hybrid Power Management Program Evaluated Ultracapacitors for the Next Generation Launch Transportation Project

The NASA Glenn Research Center initiated baseline testing of ultracapacitors to obtain empirical data in determining the feasibility of using ultracapacitors for the Next Generation Launch Transportation (NGLT) Project. There are large transient loads associated with NGLT that require a very large primary energy source or an energy storage system. The primary power source used for this test was a proton-exchange-membrane (PEM) fuel cell. The energy storage system can consist of batteries, flywheels, or ultracapacitors. Ultracapacitors were used for these tests.

NASA Glenn has a wealth of experience in ultracapacitor technology through the Hybrid Power Management (HPM) Program, which the Avionics, Power and Communications Branch of Glenn's Engineering Development Division initiated for the Technology Transfer and Partnership Office. HPM is the innovative integration of diverse, state-of-the-art power devices in optimal configurations for space and terrestrial applications. The appropriate application and control of the various advanced power devices (such as ultracapacitors and fuel cells) significantly improves overall system performance and efficiency. HPM has extremely wide potential. Applications include power generation, transportation systems, biotechnology systems, and space power systems. HPM has the potential to significantly alleviate global energy concerns, improve the environment, and stimulate the economy.

Ultracapacitors are ideal for applications such as NGLT, where long life, maintenance-free operation, and excellent low-temperature performance are essential. For these tests, state-of-the-art symmetric ultracapacitors were interconnected in an innovative configuration to minimize interconnection impedance. PEM fuel cells provide excellent energy density but not good power density. Ultracapacitors not only have excellent power density, but virtually unlimited cycle life. The combination of PEM fuel cells and ultracapacitors provides a power source with excellent energy and power density. In addition, the life of PEM fuel cells is shortened significantly by large transient loads. Using ultracapacitors in conjunction with PEM fuel cells reduces the transients applied to the fuel cell, and thus appreciably improves the life of the power system. PEM fuel cells were tested with and without ultracapacitors to determine the benefits of ultracapacitors. Neither the fuel cell nor the energy storage system exhibited any problems under the rigorous test conditions it was exposed to. The performance of the fuel cell and the ultracapacitor bank proved to be excellent. In addition, a bank of ultracapacitors was assembled and tested at 275 V, which is the nominal voltage rating of the NGLT power system. The performance of the 275-V ultracapacitor bank was excellent, and there were

no failures. Results showed that using ultracapacitors in the NGLT power system can improve space power system performance and reliability significantly.

The Hybrid Power Management (HPM) Program applied to the Next Generation Launch Transportation (NGLT) Project. Top: Fuel cell laboratory with PEM fuel cells and a bank of ultracapacitors. Bottom: Bank of 110 ultracapacitors connected in a series configuration.

Bibliography

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